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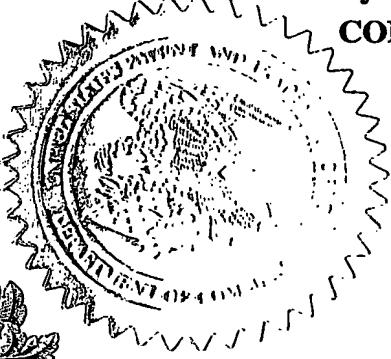
APPLICATION NUMBER: 60/492,816

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## PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

19704-1-5  
07/20/16  
U.S. PTO  
06/06/03

### INVENTOR(S)

Given Name (first and middle [if any]) <b>Colin William</b>	Family Name or Surname <b>NEWPORT</b>	Residence (City and either State or Foreign Country) <b>CANADA</b>
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Additional inventors are being named on the \_\_\_\_\_ separately numbered sheets attached hereto

### TITLE OF THE INVENTION (280 characters max)

VEHICLE FRAME HAVING ENERGY MANAGEMENT SYSTEM AND METHOD FOR MAKING SAME

Direct all correspondence to:

### CORRESPONDENCE ADDRESS

<input checked="" type="checkbox"/> Customer Number <b>28465</b>	→	Place Customer Number Bar Code Label here
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### ENCLOSED APPLICATION PARTS (check all that apply)

<input checked="" type="checkbox"/> Specification Number of Pages <b>13</b>	<input type="checkbox"/> CD(s), Number _____
<input checked="" type="checkbox"/> Drawing(s) Number of Sheets <b>11</b>	<input checked="" type="checkbox"/> Other (specify) _____
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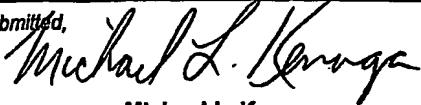
The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

No.

Yes, the name of the U.S. Government agency and the Government contract number are: \_\_\_\_\_

Respectfully submitted,

SIGNATURE



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Date **08/06/2003**

REGISTRATION NO. **34,639**

(if appropriate)

Docket Number:

**249011-000015**

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This collection of information is required by 37 CFR 1.51. The information is used by the public to file (and by the PTO to process) a provisional application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop Provisional Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**  
**PROVISIONAL PATENT APPLICATION COVER SHEET**

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**TITLE:** VEHICLE FRAME HAVING ENERGY MANAGEMENT  
SYSTEM AND METHOD FOR MAKING SAME

**ASSIGNEE:** COPPERWELD CANADA INC.

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**CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10)**

Applicant(s): Colin William NEWPORT

Docket No.

249011-000015

Serial No.

Filing Date

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Examiner

Group Art Unit

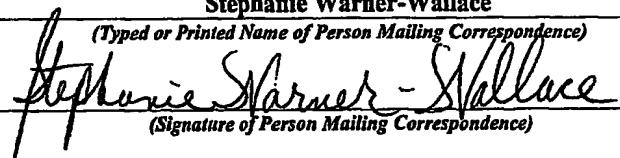
Invention: **VEHICLE FRAME HAVING ENERGY MANAGEMENT SYSTEM AND METHOD FOR MAKING SAME**

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1                   **VEHICLE FRAME HAVING ENERGY MANAGEMENT SYSTEM**  
2                   **AND METHOD FOR MAKING SAME**

3    **BACKGROUND OF THE INVENTION**

4    **FIELD OF THE INVENTION**

5    [0001]    The present invention relates to systems and methods for absorbing energy during  
6    vehicular collision. More specifically, the invention provides vehicle frame side rails having  
7    impact energy absorbing sections and methods for forming such side rails.

8    **DESCRIPTION OF THE PRIOR ART**

9    [0002]    Vehicle collisions, either between two vehicles or between a vehicle and a stationary  
10   object, result in tremendous forces that are transmitted through the vehicle frame, even at  
11   reduced speeds. These forces result from the transfer of kinetic energy from the moving object  
12   or objects and, if not adequately managed or absorbed, often lead to serious injury to occupants.

13   [0003]    Most automobiles are constructed from a conventional structural frame onto which a  
14   body and other functional equipment (i.e. engine, passenger compartment etc.) are mounted. The  
15   structural frame includes, generally, a pair of side rails extending longitudinally, one on each  
16   side of the vehicle, with transversely extending crossmembers connected to the side rails to form  
17   a ladder-like arrangement. A passenger space frame is mounted on this assembly as well as a  
18   body, engine, and other elements of the vehicle. As is commonly known, bumpers are provided  
19   on the front and rear ends of vehicles and form the impact area for most types of collisions. One  
20   type of common collisions results from one or more vehicles impacting end to end, which  
21   translates the force of the impact through the side rails. Therefore, various efforts have been  
22   focussed on absorbing the kinetic energy of an impact on the ends of the side rails, prior to  
23   transference to the passenger space frame and the passengers themselves.

24   [0004]    Various systems and methods have been proposed to absorb or dissipate the energy  
25   generated in a collision. US Patent 5,005,887 discloses a bumper fastening apparatus for

1 absorbing energy transmitted from a bumper before it reaches the vehicle frame, i.e. side rails.  
2 The bumper of this reference comprises a hollow body with a core filled with a resilient foam for  
3 absorbing energy from an impact. Although minor collisions may be tolerated with this system,  
4 much of the energy is still transmitted to the vehicle frame members and, therefore, to the  
5 occupants. Furthermore, the bulky bumper required would be difficult to incorporate into  
6 specific design constraints meant to be aesthetically pleasing.

7 [0005] US Patent 6,334,518 discloses an impact absorbing mechanism for vehicles. The  
8 device comprises a hydraulic energy absorbing device positioned between the bumper and the  
9 side rails. Such a system involves additional manufacturing time and increased cost and weight  
10 to the vehicle.

11 [0006] US Patent 5,605,353 discloses a system for absorbing energy directed at a cross  
12 member before it is transmitted to the side rails.

13 [0007] US publication 2001/0022444 discloses specifically designed side rails including  
14 energy absorbing terminal ends. The terminal ends are provided with zones of weakness and are  
15 designed to buckle and absorb impact energy. Although effective, these terminal end structures  
16 are added components that result in production delays and added component cost.

17 [0008] There exists, therefore, a need for a means of controlling or managing impact energy  
18 on a vehicle that is cost effective and does not add to production time or vehicle weight.

## 19 SUMMARY OF THE INVENTION

20 [0009] In one embodiment, the present invention provides a hollow structural member for a  
21 vehicle frame having a weakened end section integral therewith for absorbing energy by  
22 deformation on application of a force.

23 [0010] In another embodiment, the invention provides a hollow structural member for a  
24 vehicle frame having a weakened end section integral therewith for absorbing energy by

1 deformation on application of a force and is provided with an initiation site for initiating the  
2 deformation;  
3 - wherein the end section is provided with a reduced wall thickness thereby rendering the  
4 end section weaker than the remainder of the member; and  
5 - wherein the initiation site comprises a tapered portion, with respect to the member,  
6 whereby the end section has a smaller cross sectional area than the member.

7 [0011] In another embodiment, the present invention provides a method for forming a hollow  
8 structural member for a vehicle frame having a weakened end section integral therewith for  
9 absorbing energy, the end section having a reduced wall thickness, the method comprising the  
10 steps of:

11 - providing the member to be formed;  
12 - providing a first die having an opening corresponding generally with the outer  
13 dimensions of the member;  
14 - providing a mandrel for cooperating with the die, the mandrel having outer dimensions  
15 greater than the interior dimensions of the member, wherein the die is capable of sliding over the  
16 mandrel with a clearance corresponding to the desired reduced wall thickness of the member;  
17 - placing the die over the member;  
18 - moving the die over a first distance from the end of the member;  
19 - inserting the mandrel into the hollow member;  
20 - moving the mandrel over a second distance from the end of the member;  
21 - sliding the die over the member and over the mandrel thereby causing the wall thickness  
22 of the member to be reduced when the die and mandrel are in cooperation.  
23 - removing the mandrel.

24 BRIEF DESCRIPTION OF THE DRAWINGS

25 [0012] These and other features of the preferred embodiments of the invention will become  
26 more apparent in the following detailed description in which reference is made to the appended  
27 drawings wherein:

1 [0013] Figure 1 is a perspective view of a pair of side rails as known in the prior art.

2 [0014] Figure 2 is side cross sectional view of an end of a side rail according to an  
3 embodiment of the present invention.

4 [0015] Figures 3 to 11 are cross sectional views of a forming process according to an  
5 embodiment of the present invention.

6 DESCRIPTION OF THE PREFERRED EMBODIMENTS

7 A) Energy Absorbing End Portion of Structural Members

8 [0016] As discussed above, some of the prior art methods for energy management in  
9 automobiles involve the attachment, usually by welding, of extensions to the vehicle's side rails,  
10 wherein the extensions are engineered to be structurally weaker than the side rails. In this  
11 manner, the extensions result in a zone of weakness during a collision and are capable of  
12 buckling to absorb the energy of the impact. However, the attachment of these extensions  
13 involves extra production time for the welding operation and added material cost. Further, the  
14 welding process results in the adjacent areas becoming structurally affected by the heat and may  
15 lead to unpredictable mechanical behaviour of such sections during the collision. Figure 1  
16 illustrates a pair of side rails, 11 and 12, as taught in the prior art, having extensions 20 that are  
17 structurally weaker than the side rails. Such a side rail construction is taught in US patent  
18 application 2001/0022444. Generally, it is known to form members such as side rails from  
19 hollow tubes using various commonly known forming methods such as hydroforming and the  
20 like.

21 [0017] The present invention provides, in one embodiment, a tailored side rail for  
22 automobiles having, integral therewith, a zone of reduced strength. By avoiding the need for  
23 welding extensions etc., the present invention provides a cost and time effective solution to the  
24 energy management problem as well as a solution that is predictable in its mechanical  
25 characteristics.

1 [0018] The following disclosure will refer to an embodiment of the invention involving  
2 automobile side rails. However, it will be understood that this is a preferred embodiment of the  
3 invention and that the invention is not limited solely to such application. The present invention  
4 may, for example, be used for various other structural members where energy management is  
5 required. These members include vehicle structural components such as pillars, cradles etc.  
6 Further, it will also be understood that the invention can be used for either end of the side rails to  
7 accommodate front or rear impacts.

8 [0019] Figure 2 illustrates an end portion of an automobile structural member, such as a side  
9 rail, according to the present invention. As can be seen, the structural member 30 comprises a  
10 hollow elongate body of any desired shape. The member 30 includes a main body 32 having a  
11 first wall thickness or gauge  $T_1$ . The member 30 also includes an energy-absorbing end portion  
12 34 that is integral with the main body 32 but is formed of a second wall thickness  $T_2$  that is less  
13 than  $T_1$ , thereby rendering the end portion 34 structurally weaker than the main body. Further, in  
14 accordance with a preferred embodiment, the end portion 34 is tapered as compared to the main  
15 body to enhance its energy-absorbing tendency. It will be appreciated by persons skilled in the  
16 art that although tapering of the end portion serves to provide an initiation site for energy  
17 absorption, the desired effect can also be accomplished with the thin walled section itself or a  
18 graduated wall thinning. In the result, the end portion 34 provides a zone of weakness for the  
19 member 30 so as to enable it to preferentially become physically deformed in a collision prior to  
20 transfer of impact energy to the main body of the member. As indicated above, in one preferred  
21 embodiment of the invention, the structural members 30 are side rails and one or both ends of the  
22 side rails may be provided with the above-described terminal ends. In other embodiments, other  
23 structural members (such as pillars etc.) can also be provided with terminal ends as described  
24 above.

25 [0020] It will be understood by persons skilled in the art that the length of the energy-  
26 absorbing end portion 34 can be calculated depending on the amount of impact absorption  
27 required. The length of the end portion will vary depending on the wall thickness chosen. For  
28 example, to absorb a given impact force, the end portion can be tailored by adjusting either or

1 both of the wall thickness,  $T_2$ , or the length of the end portion. It will be understood that design  
2 constraints may also affect the tailoring aspect. For example, a specific design for an automobile  
3 will impose restrictions on the lengths of the side rails and, therefore, in some cases, most of the  
4 tailoring will involve adjustment of the wall thickness,  $T_2$ . The values of the length and  
5 thicknesses of the members can be determined by persons skilled in the art once the amount of  
6 energy absorption is defined. The unitary structure of the member 30 avoids any structural  
7 variables as would be found if welding processes were used to attach extensions etc. to the side  
8 rails.

9 **B) Method of Forming End Portions**

10 [0021] In another embodiment, the present invention provides a method for forming the  
11 structural members described above. The method of the invention is illustrated in Figures 3 to  
12 11. The method can be divided into two main stages: gauge reduction and tapering. The gauge  
13 reduction step serves to provide the structural member with a weakened end section that serves  
14 to absorb the energy of an impact by deforming. The tapering step serves to provide the  
15 structural member with an initiation site for such deformation.

16 **Step 1) Gauge Reduction**

17 [0022] The gauge reduction stage is illustrated in Figures 3 to 7. As shown in Figure 3, the  
18 first step of the method involves sliding a die 40 over the outer diameter of a first end 42 of a  
19 hollow tube 44 having a first wall thickness  $T_1$  and a first outer diameter,  $D_1$ . Arrow 45  
20 illustrates the direction of travel of the die over the stationary tube 44. As shown, the die 40 is  
21 configured for the tube in that the opening of the die generally corresponds to the outer diameter  
22  $D_1$  of the tube 44. Dies for this step are commonly known in the art.

23 [0023] As shown in Figure 4, the second step of the method, involves the insertion of a  
24 mandrel 46 into the lumen of the hollow tube 44, in a direction shown by the arrow 47. The  
25 mandrel is inserted over a distance "d" of the tube 44, measured from the first end 42. The  
26 distance, d, is generally and preferably, slightly shorter than the desired length of the terminal,  
27 energy absorbing portion of the structural member being formed. As explained further below, it  
28 will be understood that the mandrel can be inserted a distance greater than d and the extra length  
(T00161-0035-USP)

1 can be trimmed. However, as will be understood, this will require an added step and, therefore,  
2 may not be preferred. As shown in Figure 4, the diameter of the mandrel 46 is preferably  
3 slightly greater than the inner diameter  $D_2$  of the tube 44, which causes the tube 44 to expand  
4 slightly upon insertion of the mandrel 46. Moreover, as will be explained further below, the  
5 difference between the diameter of the mandrel 46 and the opening of the die 40 (the latter of  
6 which is generally equal to the outer diameter,  $D_1$ , of the tube 44) is less than the wall thickness  
7  $T_1$  of the tube 44. Mandrels for this step of the method are commonly known in the art.

8 [0024] Figures 5 and 6 illustrate the next step of the method wherein the die 40 is removed  
9 from the tube 44. As shown, the die 40 is slid back toward end 42 of the tube 44, in the direction  
10 shown by arrow 48, which is the opposite direction of arrow 45 shown in Figure 3. As shown in  
11 Figure 5, as the die 40 is removed, it passes over the mandrel 46, which remains in place within  
12 the tube 44. In the result, the wall thickness of the tube 44 is forcibly reduced to a thickness  $T_2$ ,  
13 which corresponds generally to the clearance between the diameter of the mandrel 46 and the  
14 opening of the die 40. It is noted that the outer diameter  $D_1$  of the tube 44 is maintained constant  
15 since, as indicated above, the die is configured to have an opening generally corresponding to the  
16 outer diameter  $D_1$  of the tube 44.

17 [0025] Figure 7 illustrates the final step of the gauge reduction stage of the method wherein,  
18 once the die 40 is removed, the mandrel 46 is also withdrawn from tube 44, in the direction 48.  
19 As shown in Figure 7, the result of the removal of the die 40 and mandrel 46 is a tube 44 having  
20 a thin walled end portion 50. The wall thickness of the end portion 50 is shown as  $T_2$ . As  
21 shown, the outer diameter  $D_1$  of the end portion 50 is preferably generally the same as that of the  
22 remainder of the tube 44. The end portion 50 of the tube 44 is of a length  $L$ , which is, as  
23 discussed above, generally longer than  $d$ , the distance the mandrel is inserted, due to the fact that  
24 the length of the tube is normally increased during the gauge reduction process. As indicated  
25 above, in the preferred embodiment,  $L$  corresponds generally to the desired length of the end  
26 energy-absorbing portion of the structural member being formed. However, in the event that  $L$  is  
27 longer than such desired length, the excess can be trimmed.

1    **Step 2) Tapering**

2    [0026]    Figures 8 to 11 illustrate the steps of the tapering the tube 44 following gauge  
3    reduction. In the first step, as shown in Figures 8, a tapered die 52 is advanced towards the end  
4    42 of the tube 44. It is noted that end 42 is the reduced wall thickness end portion 50 of the tube  
5    44. As shown in figure 8, the tapered die 52 is advanced towards the stationary tube 44 in the  
6    direction shown by arrow 54. The die 52 includes a taper of an angle  $\alpha$ , which will vary  
7    depending on the required tapering of the tube 44. The specific geometry of the tapering die 52  
8    will be apparent to persons skilled in the art based on the need.

9    [0027]    As shown in Figures 9 and 10, as the tapered die 52 is advanced over the end portion  
10   50 of the tube 44, the end portion 50 is gradually reduced in diameter to provide the tube 44 with  
11   a tapered end.

12   [0028]    In Figure 11, the tapered die 52 is shown being withdrawn off the end portion 50 of  
13   the tube 44 in the direction shown by arrow 56. The resulting tube 44 includes an end portion 50  
14   having a reduced wall thickness  $T_2$  and a tapered outer diameter. As explained above, the  
15   reduced wall thickness of the end portion 50 is structurally weaker than the remainder of the tube  
16   44 and, therefore, is more susceptible to deformation during an impact on end 42. As such, the  
17   end portion 50 serves to absorb the energy of an impact prior to it being transferred to the  
18   remainder of tube 44. Furthermore, the tapering of the end portion 50 aids the initialization of  
19   the deformation process.

20   [0029]    The tube 44, after being tapered may then be formed to the desired final shape of the  
21   structural member using any conventional process such as hydroforming etc. It will be  
22   understood that the above description refers to "diameters" of the tube and end portions.  
23   However, it will be understood that the above forming process can also be conducted on a pre-  
24   formed member having another geometry. In such case, the dies and mandrel discussed above  
25   will have the respective shapes of the member being formed. For example, the die and mandrel  
26   may have a square or rectangular design should the final tube have such geometry.

1 [0030] As mentioned above, the preferred structural member of the present invention  
2 includes an energy absorbing and unitary end portion having a thinned wall and tapered outer  
3 diameter. However, it will be appreciated by persons skilled in the art that the end portion can  
4 optionally include only one of these structural features and still provide the desired energy  
5 absorbing capacity. For example, the end portion can have either a thinned wall (where no  
6 deformation initiation site is needed) or a tapered outer diameter or geometry (where the  
7 initiation site alone serves to deform the end of the member). In such case, only the needed  
8 forming stage (i.e. either gauge reduction or outer dimension tapering) would be followed.

9 [0031] In another embodiment, the tapered section of the members can be provided along  
10 only a portion of the reduced wall thickness region while still serving to initiate deformation.

11 [0032] Further, in another embodiment, the members of the invention can include a reduced  
12 gauge as described above and, instead of a taper, they can be provided with another form of  
13 initiation site for impact absorption. An example of an initiation site is the provision of a fold in  
14 the tube end wall as known in the art.

15 [0033] Although the invention has been described with reference to certain specific  
16 embodiments, various modifications thereof will be apparent to those skilled in the art without  
17 departing from the spirit and scope of the invention as outlined in the claims appended hereto.

18

19

**THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY  
OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:**

1. A hollow structural member for a vehicle frame having a weakened end section integral therewith for absorbing energy by deformation on application of a force.
2. The structural member of claim 1 wherein said member has a first wall thickness and said weakened end section includes a second wall thickness and wherein said first wall thickness is greater than said second wall thickness.
3. The structural member of claim 2 wherein said end section is provided with an initiation site for initiating said deformation.
4. The structural member of claim 3 wherein said initiation site comprises a tapered portion, with respect to the member, whereby said end section has a smaller cross sectional area than said member.
5. The structural member of claim 3 wherein said initiation site comprises a graduated reduction of wall thickness on said end section.
6. The structural member of claim 1 wherein said weakened end section includes a tapered portion, with respect to the member, whereby said end section has a smaller cross sectional area than said member.
7. The structural member of claim 1 wherein the wall thickness of the end section comprises a graduated reduction of wall thickness.
8. The structural member of claim 1 wherein said structural member comprises a vehicle frame side rail, cradle, or pillar.

9. The structural member of claim 4 wherein said structural member comprises a vehicle frame side rail, cradle, or pillar.

10. A hollow structural member for a vehicle frame having a weakened end section integral therewith for absorbing energy by deformation on application of a force and is provided with an initiation site for initiating said deformation;

- wherein said end section is provided with a reduced wall thickness thereby rendering the end section weaker than the remainder of said member; and

- wherein said initiation site comprises a tapered portion, with respect to the member, whereby said end section has a smaller cross sectional area than said member.

11. A method for forming a hollow structural member for a vehicle frame having a weakened end section integral therewith for absorbing energy, said end section having a reduced wall thickness, the method comprising the steps of:

- providing the member to be formed;

- providing a first die having an opening corresponding generally with the outer dimensions of the member;

- providing a mandrel for cooperating with said die, the mandrel having outer dimensions greater than the interior dimensions of the member, wherein said die is capable of sliding over the mandrel with a clearance corresponding to the desired reduced wall thickness of the member;

- placing the die over the member;

- moving said die over a first distance from the end of the member;

- inserting the mandrel into said hollow member;

- moving said mandrel over a second distance from the end of the member;

- sliding the die over the member and over the mandrel thereby causing the wall thickness of the member to be reduced when the die and mandrel are in cooperation.

- removing the mandrel.

12. The method of claim 11 further including a step of providing a means of initiating deformation on said end section.

13. The method of claim 11 further including:

- providing a second die having a tapered opening;
- sliding said second die over the end section of the member to force said end section to assume the shape of the second die opening;
- removing said second die.

14. The method of claim 11 wherein said structural member comprises a vehicle frame side rail, cradle, or pillar.

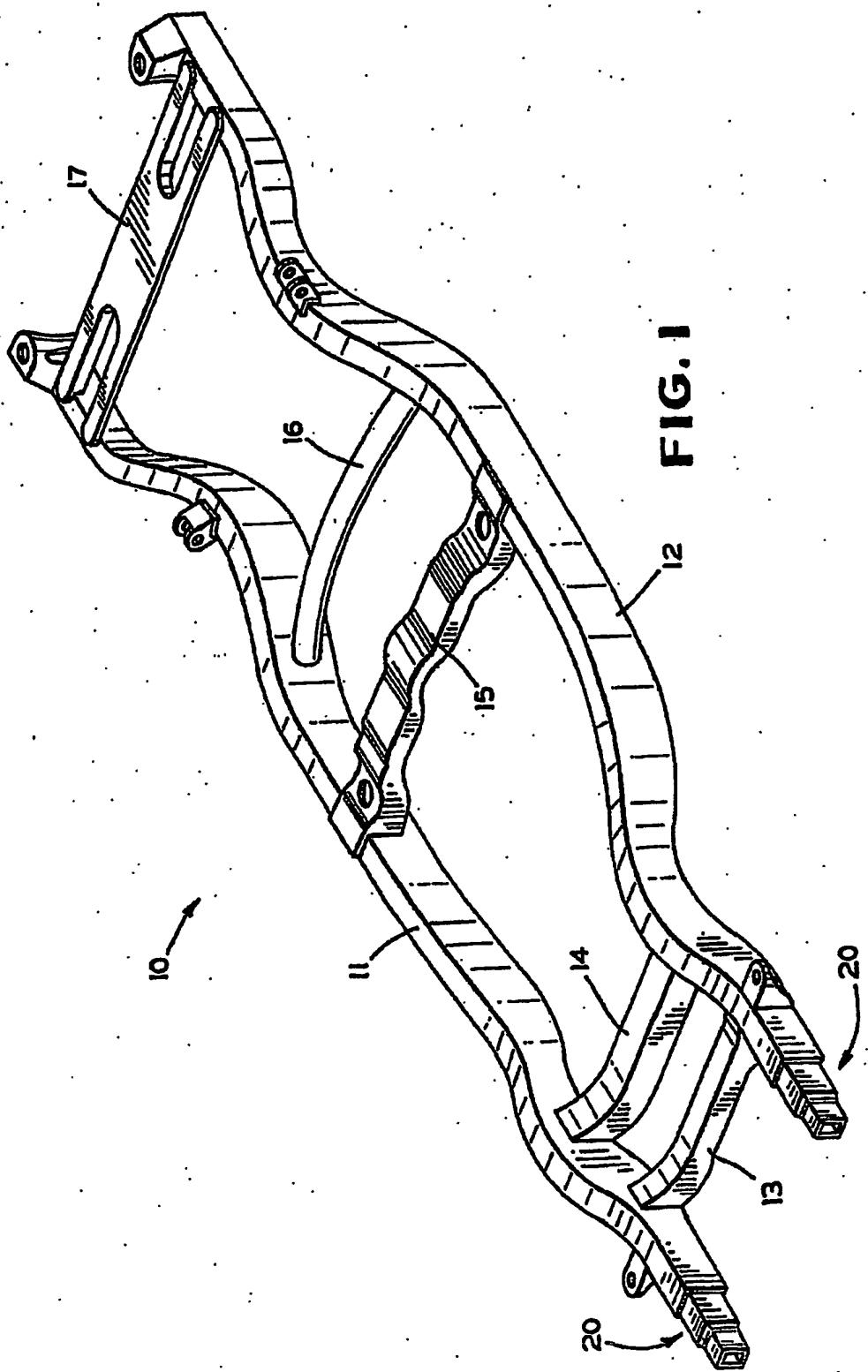
15. The method of claim 11 wherein said structural member comprises a vehicle frame side rail, cradle, or pillar.

1    **ABSTRACT**

2        A hollow structural member for a vehicle is provided with a unitary energy absorbing end  
3    portion having a reduced wall thickness, for deforming and absorbing the force of an impact, and  
4    a site for initiating such deformation. The initiation site preferably comprises a taper of the end  
5    section. A method for forming the structural members includes the steps of reducing the wall  
6    thickness of the member end section and subsequent tapering of the end section.

7  
8

**FIG. 1**



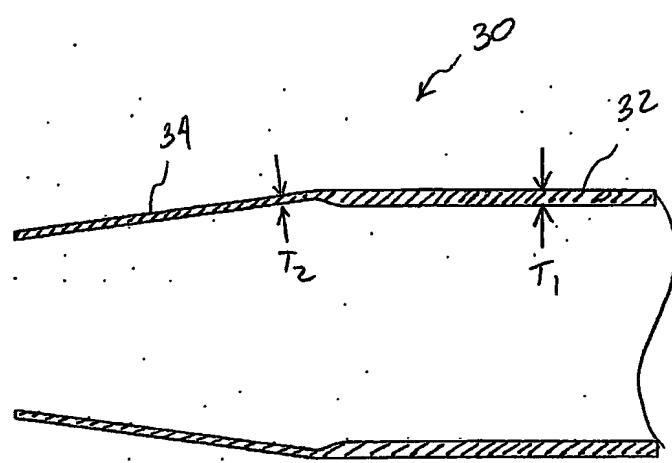


FIG. 2

# STAGE 1

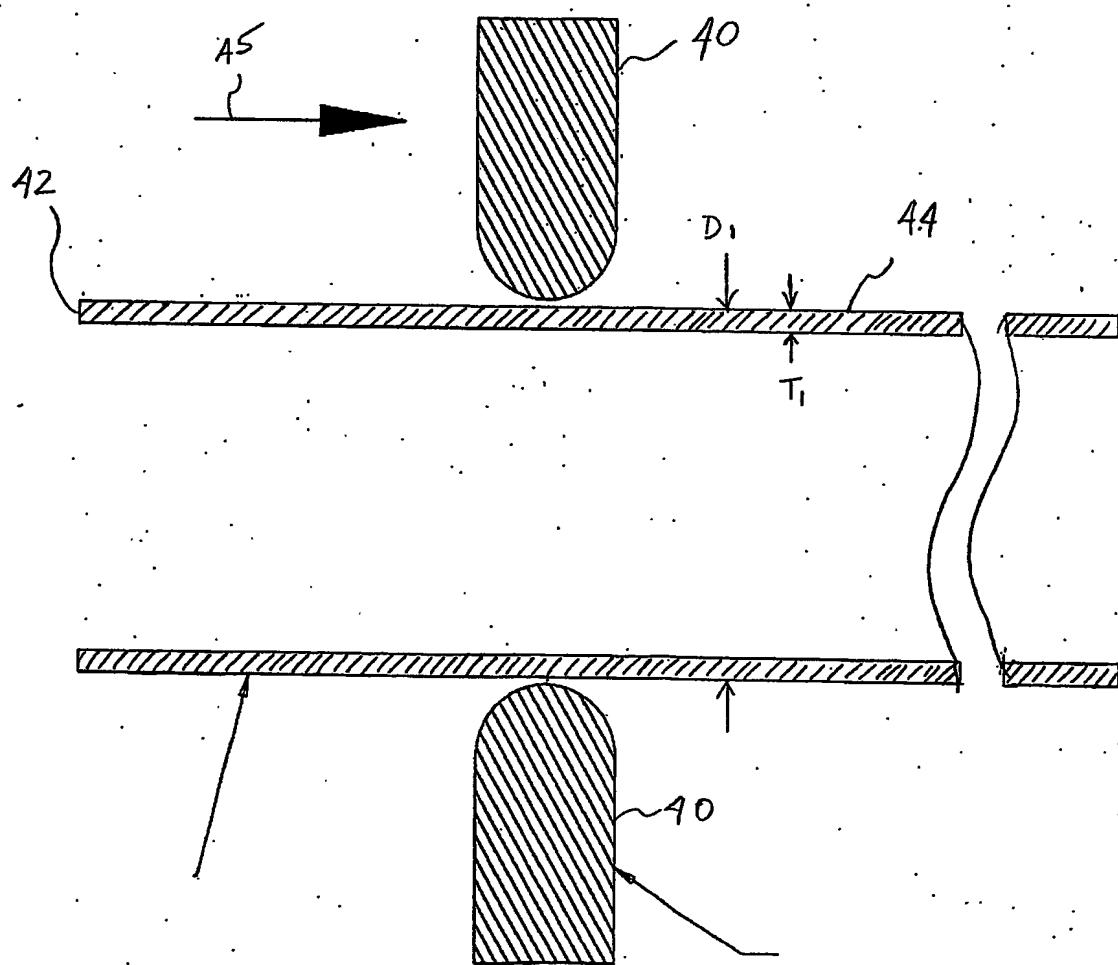


FIG. 3

## STAGE 2

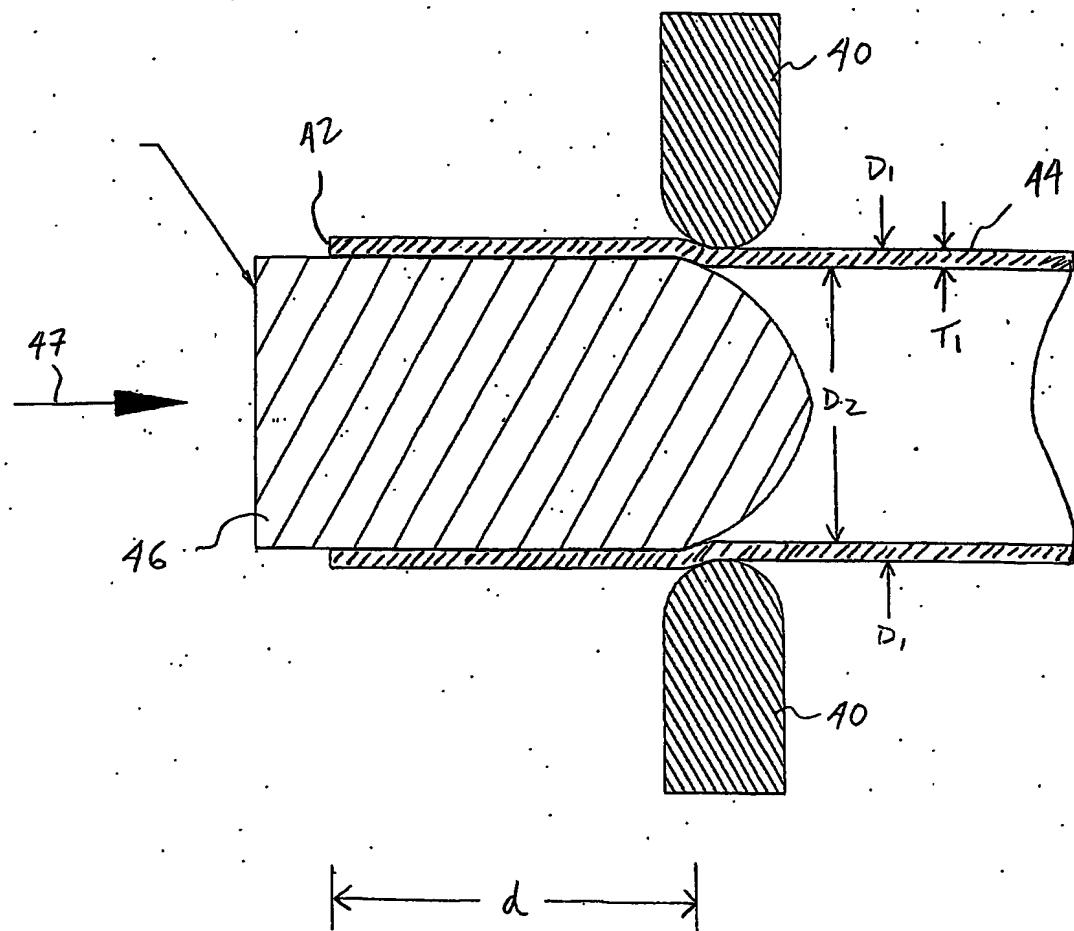


FIG. 4

# STAGE 3

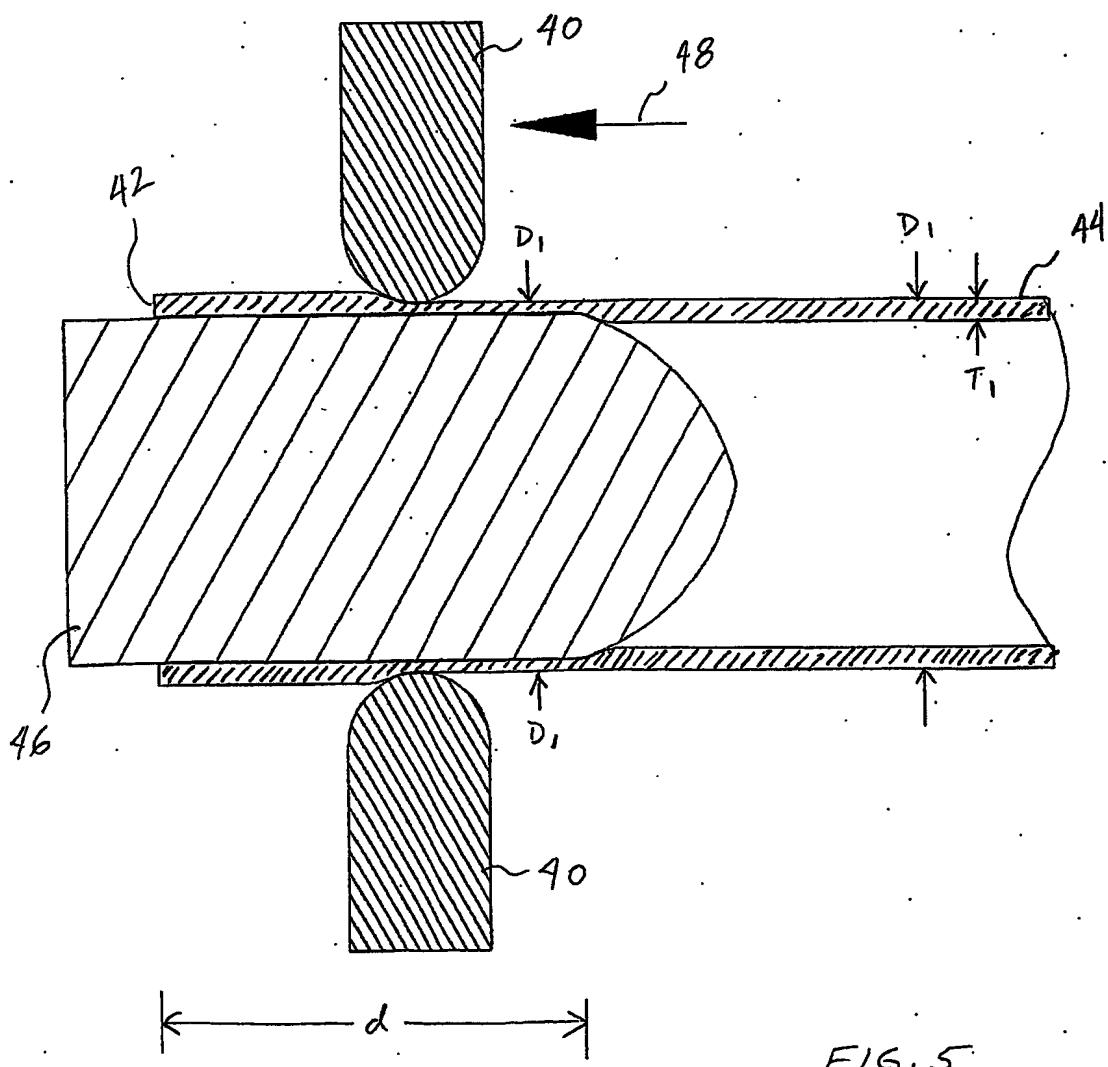


FIG. 5

# STAGE 4

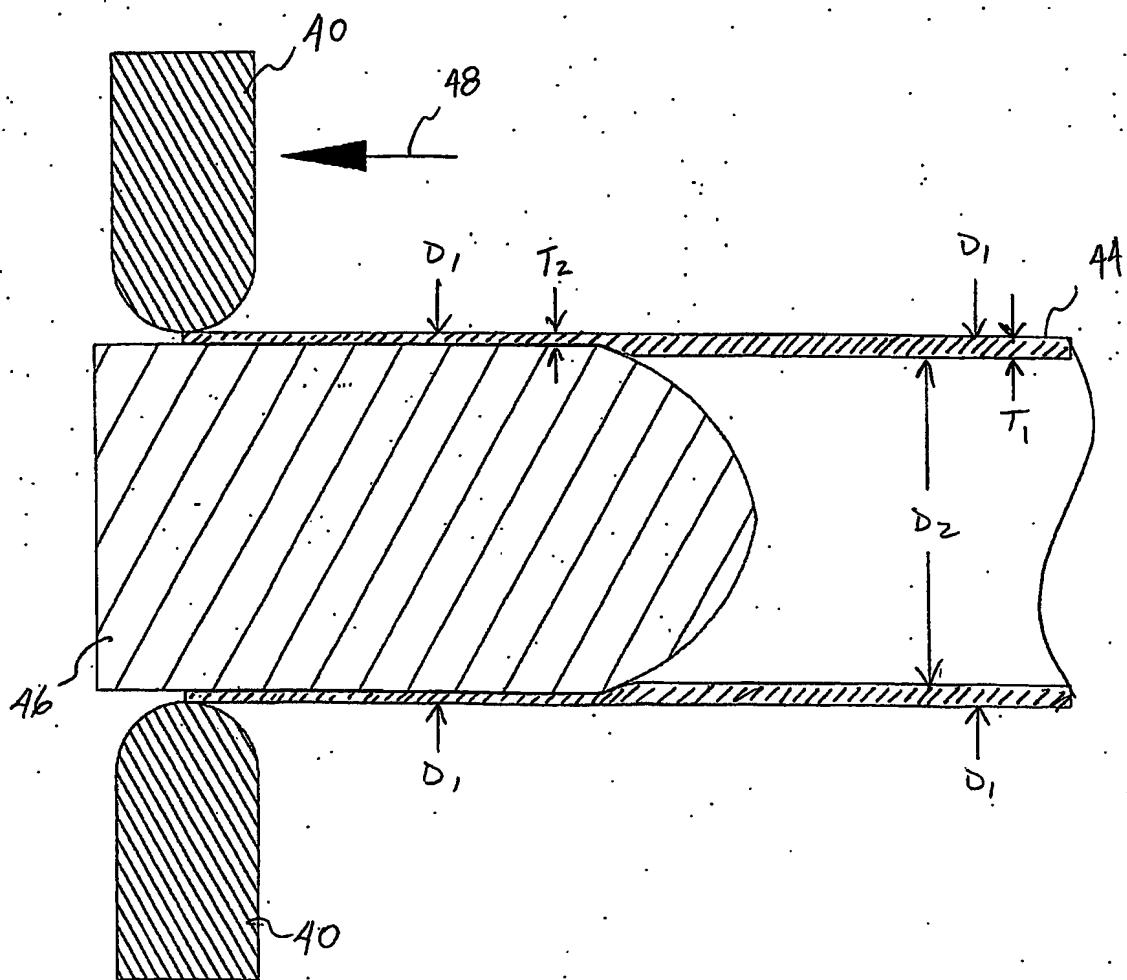


FIG. 6

## STAGE 5

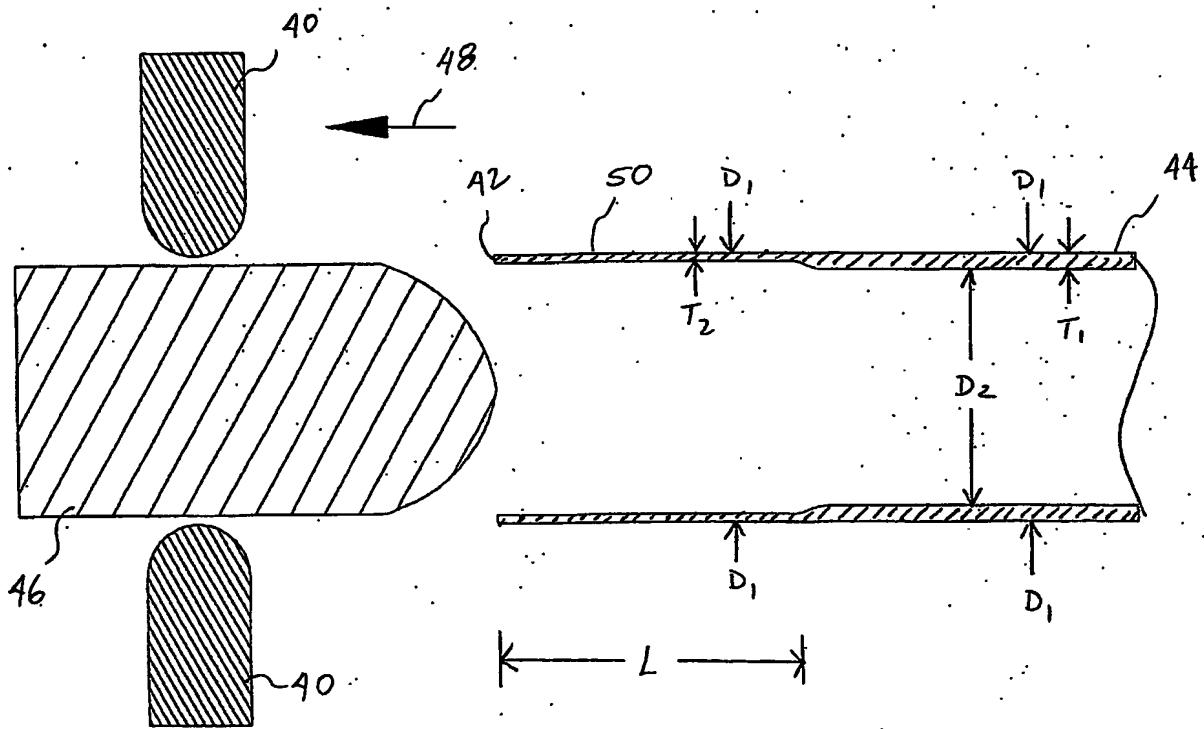


FIG. 7

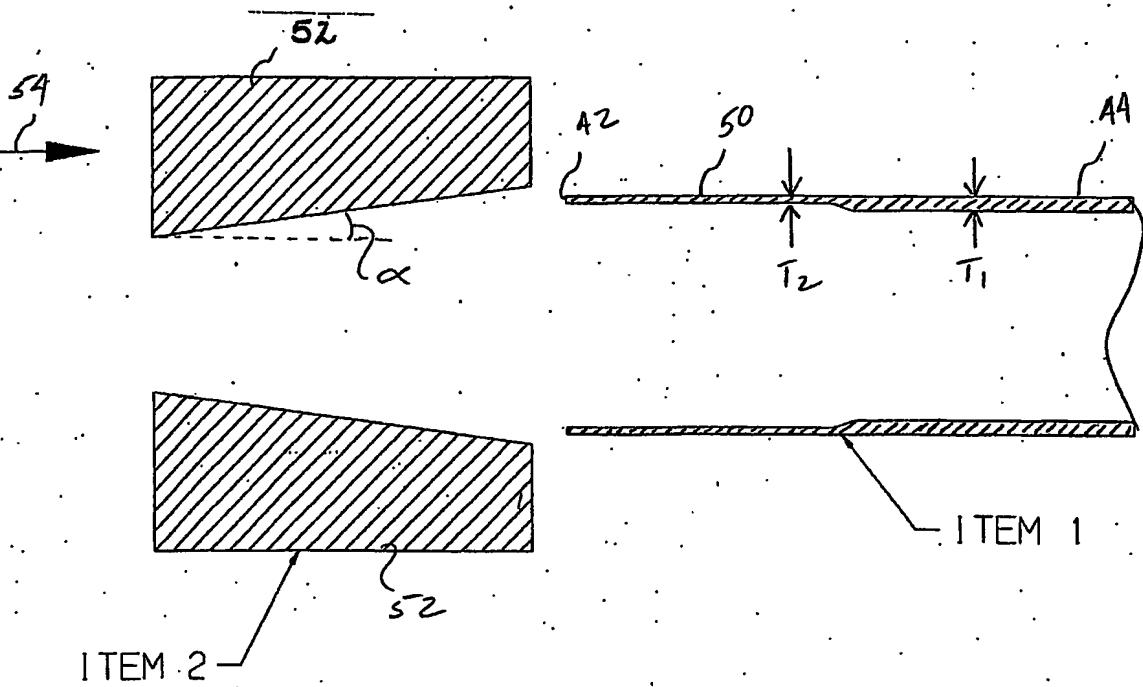


FIG. 8

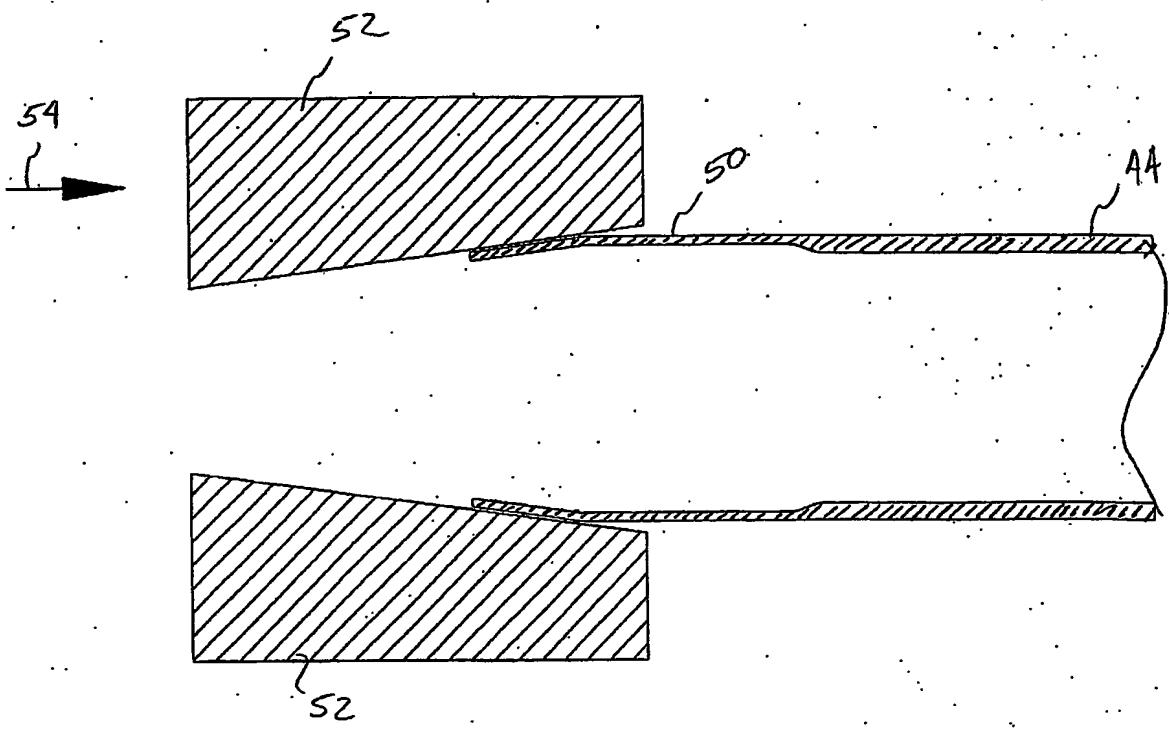


FIG. 9

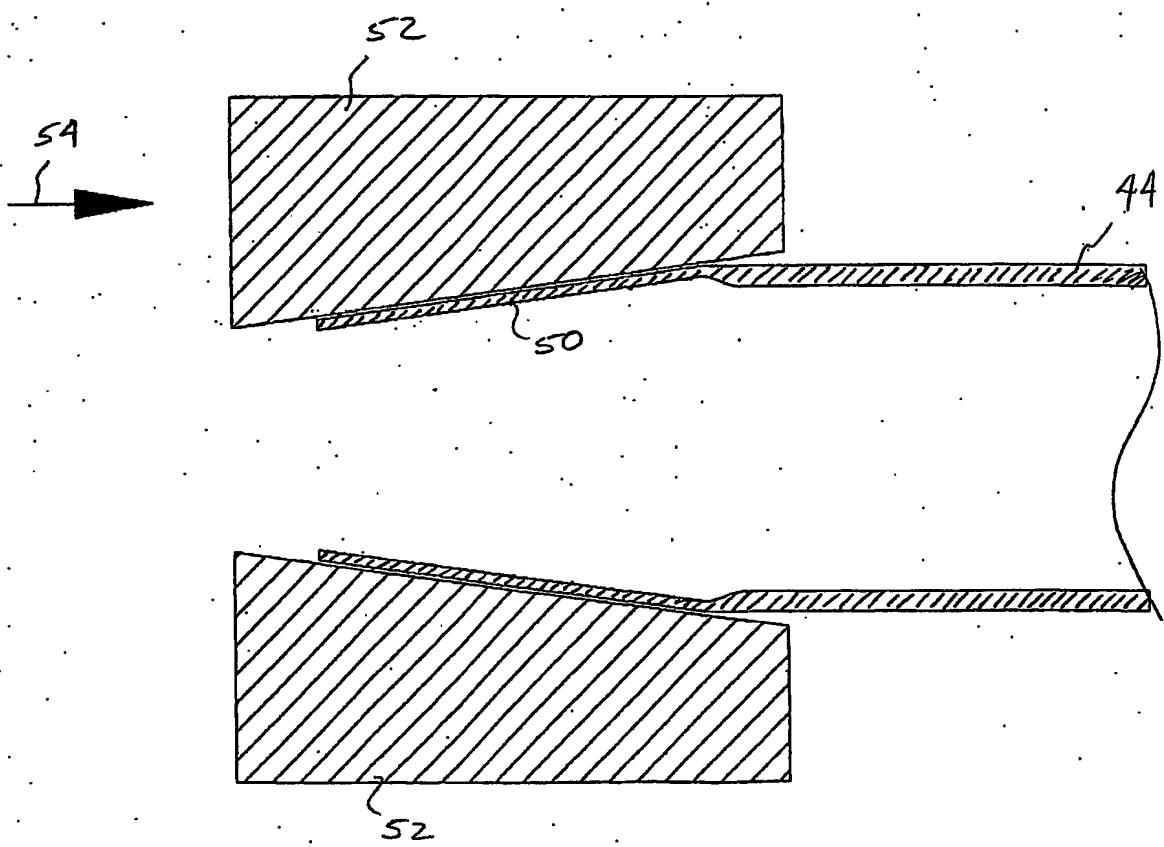


FIG. 10

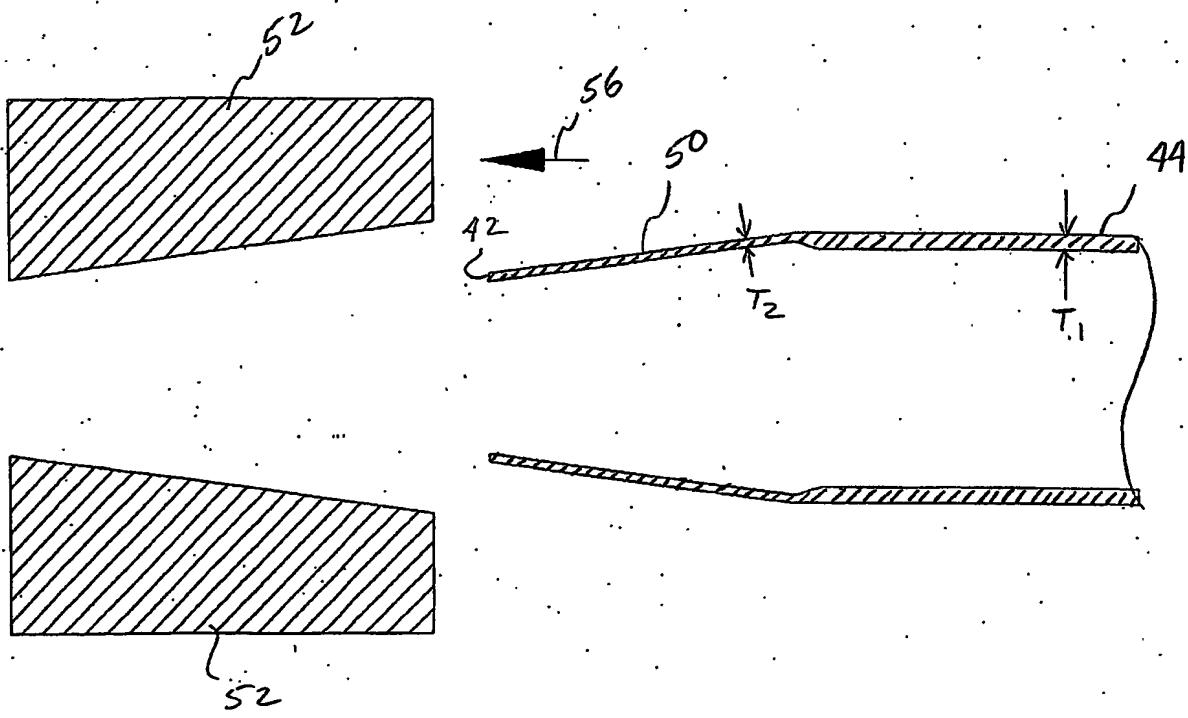


FIG. 11